

CS2.201: Computer Systems Organization

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Assignment 1

Deadline: 23:55, 10/03/2021

Welcome to Assignment 1 of the Computer Systems Organisation Course. The aim of this assignment is to familiarize you with writing x86 code. On completion of this assignment you should be able to successfully write arithmetic, conditional, looping components, procedure calls, conditional jumps and stacks in x86-64.

Instructions: Read all the instructions below carefully before you start working on the assignment.

- There are 5 problems for this assignment.
- Writing complete code with successful execution guarantees full marks. Failure on test cases will result in penalisation. Therefore ensure all edge cases are handled.
- The assignments will be manually evaluated for plagiarism. Any and all forms of plagiarism will result in zero marks for this assignment.
- Write well-organised code using procedures for repeated operations.
- Hard coded solutions will get a straight zero.
- Comment every line of your code and justify why you write that statement. 5 marks for commented code.
- Total marks for assignment is 60.

Submission format: Strictly adhere to the following submission format. Failure to do so may result in an erroneous evaluation of your assignment.

- The following directory structure is expected,

```
./<roll_number>
├── q1
│   ├── q1.s
│   └── q1.c
├── q2
│   ├── q2.s
│   └── q2.c
├── q3
│   ├── q3.s
│   └── q3.c
├── q4
│   ├── q4.s
│   └── q4.c
└── q5
    ├── q5.s
    └── q5.c
```

- Zip the `./<roll_number>` folder and name the zipped folder as `<roll_number_assign1.zip>`

Problem 1:

5 marks

Check if a given integer (64-bit) number, N , contains an odd number of 1s in its bit representation.

Input/Output Format

- INPUT: You will be given an integer N .
- OUTPUT: **TRUE**, if the given number contains odd number of 1(s), **FALSE** otherwise.

Sample Test Case

Input: $N = 153$

note: Bit-wise representation of $153 = 010011001$

Output: **FALSE**

Problem 2:

5 marks

Given a matrix A of dimension $N \times M$. Find the transpose of the matrix A .

Input/Output Format

- INPUT: N , M , and A .
- OUTPUT: Transpose of matrix A

Sample Test Case

Input:

2 3

1 2 9

0 4 7

Output:

1 0

2 4

9 7

Problem 3:

10 marks

Given integers N and M . Find modulo of sum of the prime numbers less than N with M .

Input/Output Format

- INPUT : N , M .
- OUTPUT: (Sum of prime number less than N)% M .

Sample Test Case

Input : 10 999

Output: 17

Problem 4:

15 marks

The N-Queens Problem: Place N queens on an N x N chessboard such that no two queens attack each other.

Input/Output Format

- INPUT: You will be given an integer N.
- OUTPUT: Return any one solution to the N-queens problem.

Sample Test Case

Input: 4

Output:

0 0 1 0

1 0 0 0

0 0 0 1

0 1 0 0

Problem 5:

20 marks

Everybody knows the classical puzzle about Hanoi Towers. There are three rods and one of them has n rings in ascending order of radius, the biggest disk is at the bottom, smallest is at the top. The objective of the puzzle is to move all of the rings to another rod in a minimal number of steps and preserve the disk order. During one step you are allowed to move only one ring and smaller radius rings can only be put on top of bigger radius rings.

You are required to solve modified Hanoi Towers puzzle. You have four rods instead of three. All other rules are left unchanged.

Input/Output Format

- INPUT: A single integer number N — the number of rings on the first rod.
 $0 < N < 200$.
- OUTPUT: The minimal number of steps

Sample Test Case

Input: 8

Output: 33